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Meeting Dairy Market Sanitation Requirements Economically

A PRELIMINARY REPORT

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AGRICULTURAL RESEARCH SERVICE
Washington, D. C.
May 1954

The study reported here was made under authority of the Agricultural Marketing Act of 1946 (RMA, Title II). The field work was done by the Doane Agricultural Service, Inc., St. Louis Mo., under contract (No. A-1S-32653) with the United States Department of Agriculture. The general plan of work was developed through consultation with the contractor, representatives of the Agricultural Research Service - the Production Economics Research Branch (formerly part of the Bureau of Agricultural Economics), the former Bureau of Plant Industry, Soils, and Agricultural Engineering, and the former Bureau of Dairy Industry - and representatives of the Illinois and Missouri Agricultural Experiment Stations.

Representatives of the United States Public Health Service, the Illinois Department of Public Health, and the Missouri State Division of Health were also consulted on certain aspects of the problem during the initial planning stages. Other valuable technical services and material contributions were provided by numerous manufacturers of structural materials, equipment, and cleansing agents.

All quality tests were made under the supervision of F. R. Smith in the laboratory of the Pet Milk Company at Greenville, Ill.

This preliminary report is published to make available more quickly general information about the project and to present some of the preliminary conclusions. A final report is being prepared.

CONTENTS

	Page
Summary	3
Introduction	4
Scope of study	4
Method of study	8
The quality of milk	9
Buildings	13
Use of labor	22
Suggestions	
For dairy buildings and general management practices	24
For sanitation practices	25

MEETING DAIRY MARKET SANITATION REQUIREMENTS ECONOMICALLY

by
C. J. Fenzau,
Doane Agricultural Service, Inc.
and
R. N. Van Arsdall,
Production Economics Research Branch,
Agricultural Research Service 1/

SUMMARY

A 3-year study of nine farms in the St. Louis milkshed indicated that with good practices, milk of consistently high quality can be produced with a relatively low investment in buildings, and with half or less labor than is commonly used on farms. Facilities for dairying were provided either by new construction or by extensive remodeling.

New dairy buildings and equipment for herds of 20 to 30 cows were provided for an investment at 1950 prices of about $200 per cow in the herd. Facilities consisted of open sheds for loose housing, ground-level storage for hay and silage, paved barnlot, elevated milking stalls, a milk-handling room, a pipeline milker, spray-cooler, water system including heater, and other milk-room facilities for storing and cleaning equipment.

Chore labor was reduced from 155 or more hours on the average to less than 60 hours per year per cow. This was done by a combination of such measures as pipeline milking in elevated stalls, increasing the size of herd, use of good management practices, planned arrangements for feeding and handling animals, ground-level storage of feed and bedding, and separation of dry stock from the milking herd.

Effective sanitation was obtained by using established practices in properly cleaning cows, promptly and adequately cooling the milk, using detergents and other chemical agents and mechanical means for cleaning, and maintaining equipment. Separating the milk-handling room from the milking area did not affect the quality of milk. Good practices were hampered when the water supply was inadequate, or when conditions were not conducive to habits of cleanliness.

1/ Field supervisor of project operations, Industrial Research Division, Doane Agricultural Service, Inc., and Agricultural Economist, Production Economics Research Branch, Agricultural Research Service, United States Department of Agriculture, respectively. Helpful suggestions were made by Deane G. Carter, Department of Agricultural Engineering and W. O. Nelson, Department of Dairy Science, University of Illinois and by Thayer Cleaver, Agricultural Engineering Research Branch, Agricultural Research Service, United States Department of Agriculture, who also conducted some of the chore time and travel studies. D. B. Ibach, Production Economics Research Branch, Agricultural Research Service, served as representative of the Department contracting officer and contributed to the report.

The predominance of sanitation practices in influencing quality of milk, as compared with features of structures or of regulations that prescribe specific details of buildings and equipment, is clearly indicated.

INTRODUCTION

Research and experience have established the value to dairy farmers of good sanitation practices, the importance of prompt and adequate cooling of milk, and the need for careful operation and cleaning of milking and milk-handling equipment. But how do the different features of farm dairy buildings and equipment influence the quality of milk as reflected by laboratory tests? And what is the most economical investment in buildings, equipment, and use of labor that is consistent with production of milk of a quality acceptable for consumption in fluid form?

The study reported here was undertaken on several farms to obtain answers to the two questions listed above. Conditions were established that would enable operators to follow desirable sanitation and management practices, using a combination of buildings and facilities which represents a substantial reduction in investment and in annual cost. These conditions would also reduce the amount of labor needed. This preliminary report is largely a case study of one farm.

SCOPE OF STUDY

Studies were conducted over a 3-year period on nine farms in the outer areas of the St. Louis milkshed in southwestern Illinois. Three groups of farms were included as follows:

I. Three farms on which new buildings and equipment were installed step by step.

II. Four farms on which existing buildings were extensively remodeled for dairy operation.

III. Two farms on which complete dairy systems were constructed at the beginning of the study.

Detailed records and samples of milk were also taken on four control farms that were already producing grade A milk for the St. Louis market (figs. 1 and 2). On three of these farms no changes were made. But, midway in the study, one operator shifted from a stall barn to an elevated two-stall milking room with loose housing. Thus, data on both systems under one operator were obtained.

Figure 1.- This dairy barn on a grade A farm (No. 30) had 22 stanchions and a number of box stalls and pens for young stock. After 1½ years of study with these facilities the building was remodeled into a loose-housing system, with a two-stall elevated milking room and stainless steel pipeline milker.

Figure 2.- Interior of stall barn on grade A farm (No. 30). This area was later remodeled for feeding hay and silage.

Eventually all structures in the experimental groups were of the loose housing type. On the seven farms in groups I and II on which successive phases or stages of improvement were made, only minimums were provided in the first phase to enable the owner to begin operations. Each phase was maintained for 4 to 6 months. This gave the operators time to adjust to changes and allowed time to obtain adequate records. By the end of the 3 years these farms were provided with structures and equipment which conformed to the current requirements of Illinois law with respect to production of grade A milk. Although approval under existing grade A regulations was not an objective of the project, all farms were inspected at some time in the 3 years and were approved for production of grade A milk by inspectors of the Illinois Department of Public Health.

Investigations were begun in March 1950 and continued through June 1953. During the first 2 years operators were given no instruction regarding practices and equipment, other than that they obtained through ordinary channels. In the third year guidance was given as needed to improve sanitation or other management practices.

On the farm used as the principal basis of this report (No. 5, Group I), improvements were made in various steps so that each principal change could be evaluated. Records were kept as to quality of milk, cost of buildings, and use of labor. Possibilities for improvements in plan, buildings, and management were indicated as the study progressed (figs. 3 and 4).

Figure 3.- The condition of the old dairy barn on farm 5 did not warrant remodeling. It was converted for ground-level storage of hay and shelter for calves and a bull.

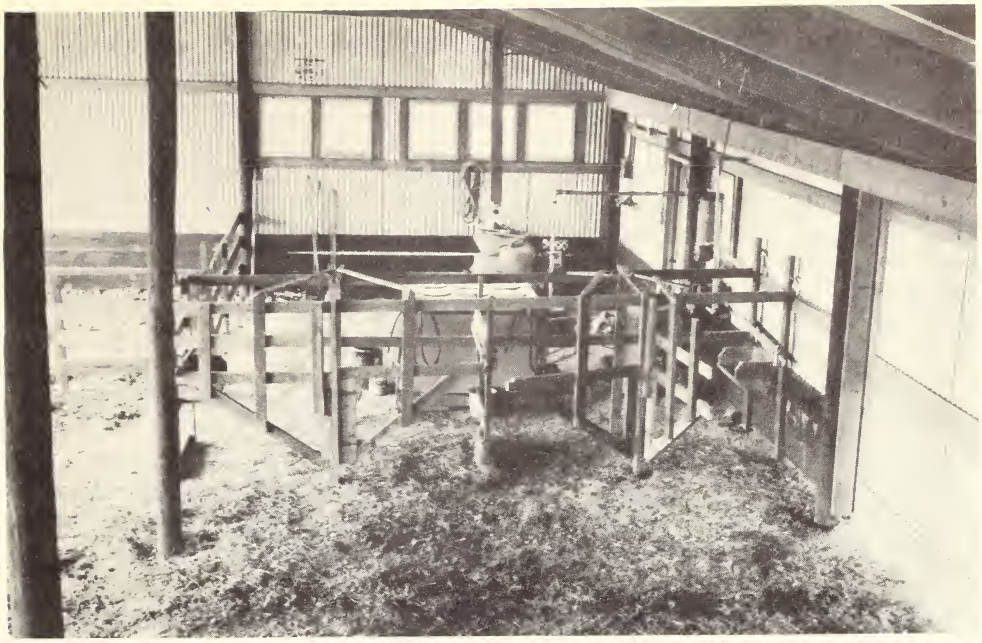

Figure 4.- Type of temporary milking facilities used on four farms during phase 2. The arrangement was similar to the permanent facilities eventually built. Pipeline milkers carried the milk direct to cans in a spray-type cooler.

The phases of change on this farm were as follows:

1. Cows were hand milked in old barn.

2. A new shelter shed was built. Two wooden milking stalls were set on the earthen floor at ground level. A pipeline milker and spray cooler were installed.

3. Phase 3 involved a single enclosed milking and milk-handling area without paved floors. (On farm 5 construction problems required going directly from phase 2 to phase 4.)

4. Milking area enclosed. Two elevated stalls and concrete floors were added.

5. Partition installed between milking room and milkroom.

METHOD OF STUDY

Quality of the milk produced was taken as the primary measure of adequacy of buildings and equipment. Data on quality of milk were derived from samples taken under the conditions described for each phase. Data on the labor required were assembled from records kept by the farm operators and from time and travel studies carried on during the different structural phases. Because of limitations in area and number of farms covered each farm was treated as a separate case study. Thus, the findings on cost apply only to structures built or remodeled in this or a similar area.

Structures and Equipment.- Data on costs are in terms of local retail prices for materials and equipment. Costs of labor were obtained by applying prevailing wage rates to the amount used. The influence of the various facilities and arrangements on labor, space utilized, amount of bedding, capacity, investment and annual cost, and quality of milk determined their effectiveness.

Labor Analysis.- Each operator kept day-to-day records of the time required for each major division of chores. Precise time and travel studies with stop watch and measured distances were made to obtain one or more records for each phase of operation. Time requirements were also established for such items as milking with bucket milker and into a pipeline and idle time of operator or equipment, and to permit comparisons with other methods. Records show the total time required per cow per year and also the time required for individual operations.

Milk Samples.- Usually, samples of both morning and evening milkings were collected weekly, shortly after morning chore time. Sterile sampling equipment was used. The samples were placed in an ice chest and delivered to the laboratory where tests were started by 9:30 a.m. Each sample was a composite of all milk of each milking to be tested from a given farm. One can was left undisturbed for a sediment test. Extra samples were taken as needed.

Quality Tests.- Tests for sanitary quality of the milk were made as outlined by the American Public Health Association. 2/ Methylene blue and resazurin tests, plate counts and classification, microscopic grade and classification, plate counts of pasteurized samples, and sediment tests were included.

Supplementary Data.- Additional facts were recorded at each sampling to assure complete information for interpretation of the data on quality of milk. Record was made of the temperature of the outside air, the air in the milking area, the cooling water, and each can of milk. The time was recorded for the interval between sampling and icing of the sample. Observations were made as to cleanliness of cows, milking operations, milk-handling areas, equipment, and utensils. Dates, weather, quantity of milk, and any unusual occurrences were recorded.

THE QUALITY OF MILK

Preliminary analysis of data from the nine experimental farms in the study shows that milk of high quality can be produced with no more than half the labor and half the investment in structures and facilities commonly found on dairy farms in the area. 3/ Operators who followed recommended sanitation practices and used effective cooling systems produced milk with bacteria counts that were acceptable by grade A standards.

Even when milking was done in temporary stalls on an earthen floor in an open shed without an enclosed milking area, most of the samples tested were acceptable. 4/ For example, of 97 samples taken from three experimental farms with only these facilities, 85.5 percent tested less than 200,000 bacteria per milliliter, and 52.5 percent tested less than 20,000. These results with these "minimum" facilities, were obtained before the sanitation-practices program was stabilized. Operators tried to follow good practices during this period, but they were not then experienced in the practices needed to assure a stable level of high-quality milk. In comparing results with those of the more experienced producers, this fact should be taken into account. Representative samples from the four grade A control farms showed 98 percent testing under 200,000 bacteria per milliliter and 70.4 percent under 20,000. 5/

Figure 5 summarizes the quality of milk obtained on farm 5 through the various changes in structures, equipment, and practices. In the first phase, the operator hand milked a small herd in his old barn. Cleaning facilities were inadequate and no mechanical cooling device was available. In this phase, 50 percent of the milk samples gave raw plate counts about 500,000.

2/ American Public Health Association, Standard Methods for the Examination of Dairy Products. Ed. 9. 1948.

3/ See Economic and Functional Characteristics of Farm Dairy Buildings. Ill. Agr. Expt. Sta. Bul. 570. November 1953 (ARS cooperating.)

4/ For purposes of this report all references to quality results are based on raw plate counts of night milk samples taken at farm 5 after the morning milk. The milk was held under farm conditions for 12 or more hours before it was collected and taken to the laboratory for testing. The final report will include results based on all samples taken from all the farms.

5/ See "Sanitary Milk Control and its Relation to the Sanitary Nutritive and Other Qualities of Milk", National Research Council Publication 250. 1953, National Academy of Sciences, Washington, D.C., for discussion of acceptable standards. Also "Grade A Milk Law", Illinois Department of Public Health Cir. 135, September 15, 1951.

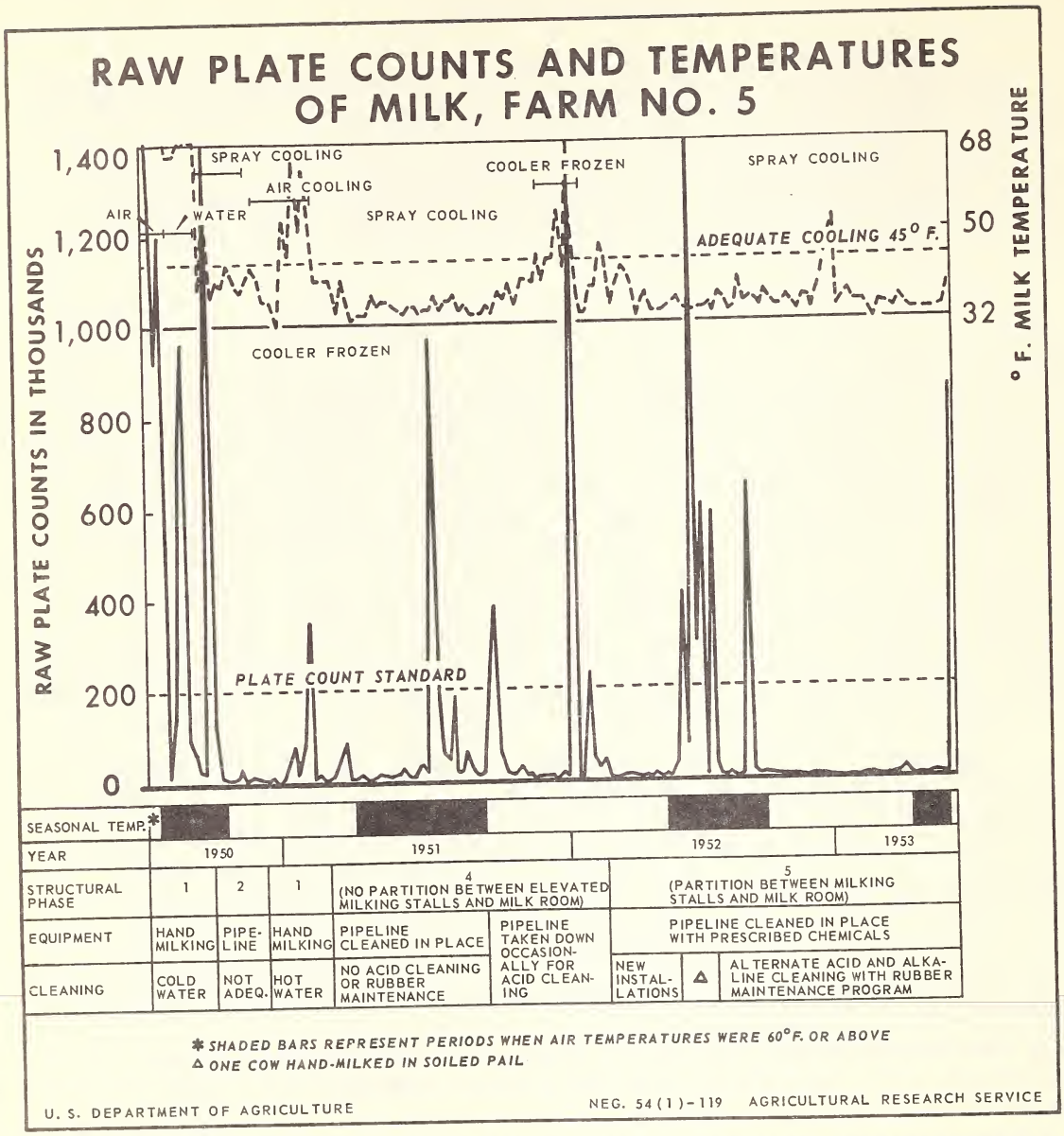

Figure 5.- Raw plate counts and temperatures of milk at time of sampling of all PM milk samples, farm No. 5.

After the pipeline milker and spray cooler were installed, the quality of the milk was well within acceptable levels. Quality dropped only when the cooler was not working or when trouble occurred because cleaning and maintenance of equipment was inadequate.

During the third year of the study, the bacteria count was consistently low. The structural work had been completed, the cooler was operated constantly, and prescribed recommendations as to cleaning and maintenance of equipment were followed.

Figure 6 illustrates the quality of milk from a grade A farm (No. 30). This farm was one of the two better control farms with respect to quality of milk. The dairying operations were carried out first in a stall barn with bucket milkers, then in a loose housing system with elevated stalls and a pipeline milker. As shown in figure 7, milk produced by these two systems was of comparable quality.

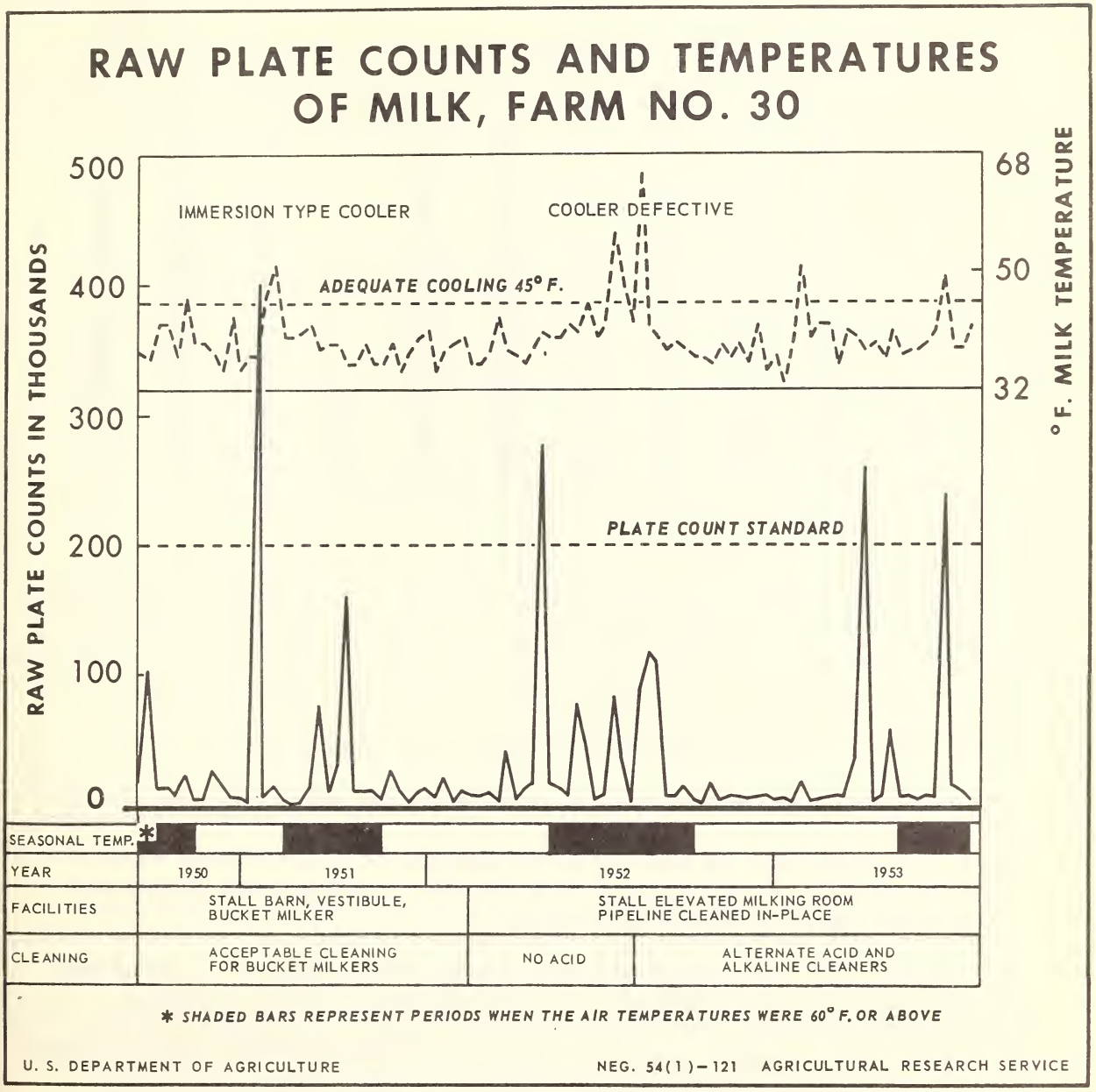

Figure 6.- Raw plate counts and temperatures of milk at time of sampling of all PM milk samples, farm No. 30.

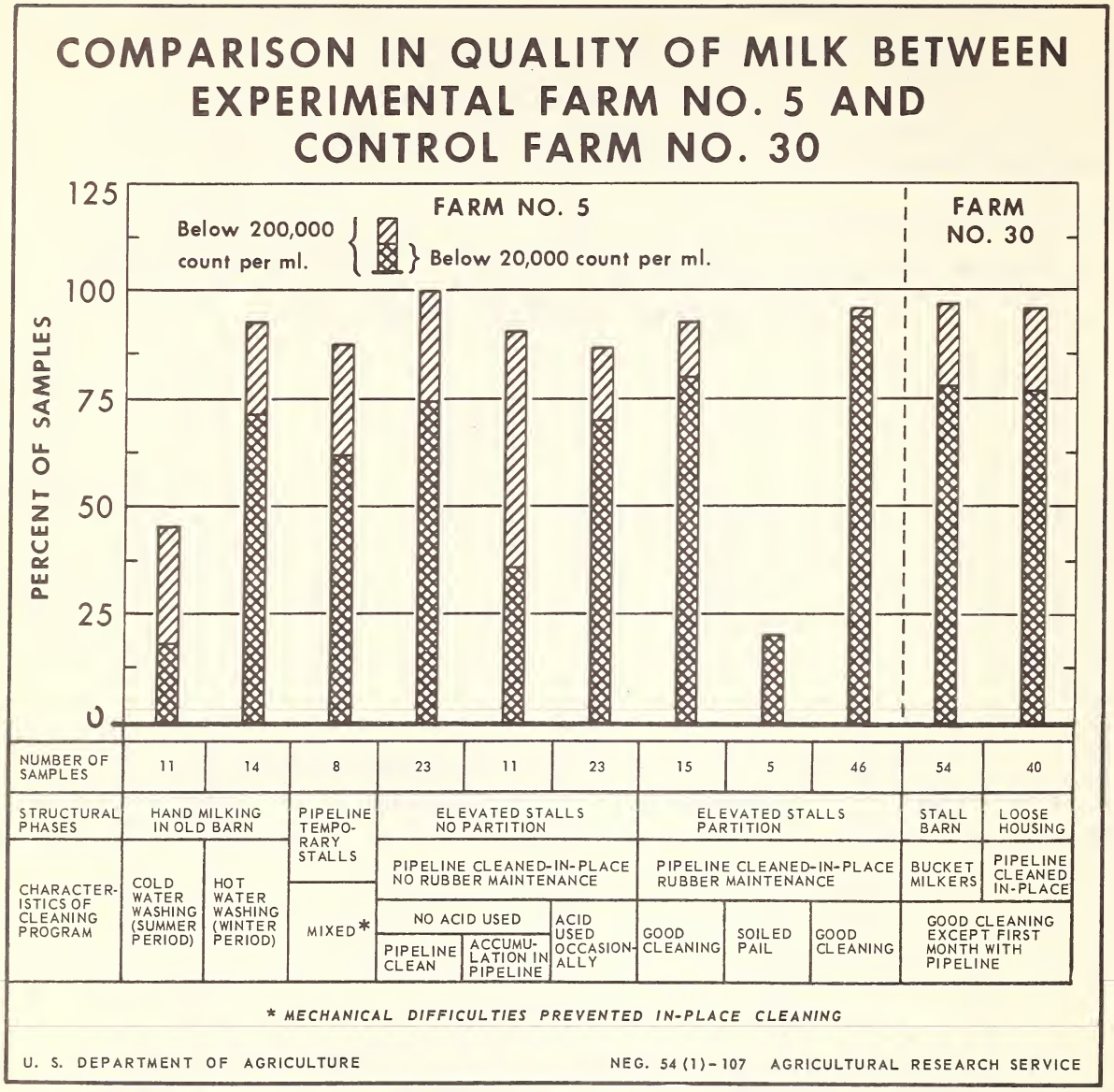

Figure 7.- Comparison in quality of PM samples of milk between experimental farm No. 5 and control farm No. 30, by structural phases and characteristics of cleaning program.

Structural facilities were not of major importance in producing milk of high quality. Figure 7 shows the quality of milk produced throughout the various structural phases on farm 5 as compared with that produced on control farm 30. Except for short periods during phases 1 and 5, 88 percent or more of all PM samples from farm 5 were under 200,000 plate count.

In comparing the two farms, it should be noted that on farm 5 both structures and practices changed during the test period while on farm 30, the sanitation program was relatively constant. Even so,

the proportion of samples under 20,000 count was comparable to or higher than that of samples from the grade A farm, except for periods of inadequate cooling or poor sanitation. Figure 7 shows the effects of keeping equipment clean and of good sanitation practices. High counts occurred on farm 5 in the initial hand-milking period (phase 1) without cooling; during phase 4 when improper cleaning and poor maintenance caused trouble; and briefly in phase 5 when use of soiled utensils affected the count.

Production of milk of high quality, once established by effective sanitation and cooling, was not affected by the development of relatively low-cost buildings, by arrangements that reduced the amount of labor required, or by increases in size of herd.

BUILDINGS

As mentioned previously, data obtained in the study showed that structural characteristics of dairy buildings may vary considerably without adversely affecting the quality of milk. There was no evidence that buildings affected quality, except as they made it easier for the operator to follow good sanitation practices. But the arrangement of buildings and of work areas within buildings affected amount of labor needed, work routines, capacity of buildings, quantity of bedding required, and thoroughness of management practices. Thus, amount of investment and arrangement for economical operation are primary considerations in any dairy building program. Effective arrangement makes the work easier and thus promotes good sanitation.

Farm 5 is an example of progressive improvement from an old barn to a loose-housing arrangement. Figures 8 through 10 show the major changes in the building program. Figure 11 indicates proposed changes for increasing efficiency and enlarging the capacity to about 50 cows through improvements derived from the study.

One major change would be in arrangement of the milking stalls. Maximum milking efficiency could not be obtained with the two stalls illustrated in figure 11. Time studies showed that with just these two stalls only 17 to 22 cows were milked per hour of milking chore time and that machines were frequently idle for 2 to 4 minutes between cows.

Data from other farms using two elevated milking stalls, and two pipeline milker units, plus a preparation stall, showed that the rate of milking could be increased to 25 to 30 cows per hour. This was done mainly by reducing the time machines were idle; on two farms with this arrangement, machines were idle between cows for only 0.6 minute. See figure 12 for illustration of a preparation stall.

Other improvements shown in figure 11 include a milking and milk-handling area separate from the resting barn; use of the old barn exclusively for hay; an additional paved lot; and a shed attached to the silo to shelter young stock and dry cows.

ORIGINAL DAIRY BARN

Farm No. 5

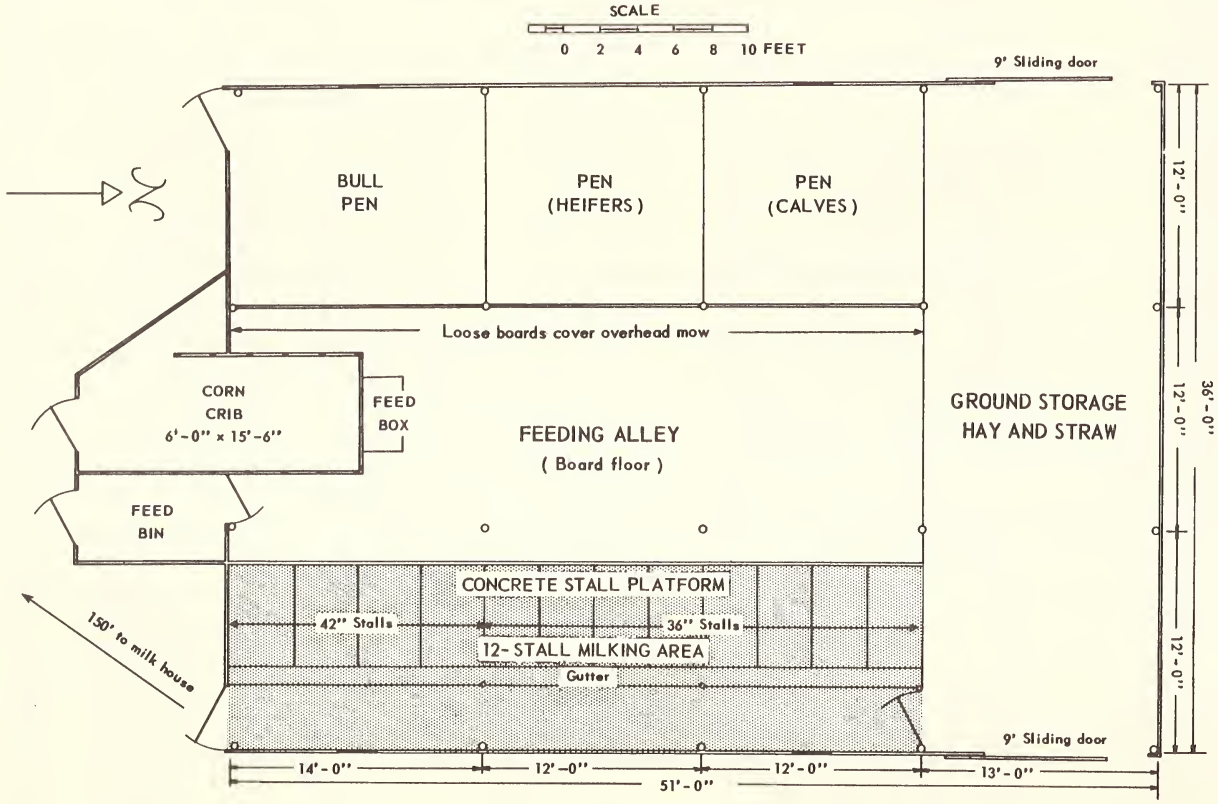

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Figure 8. - Original dairy barn now used principally for storage of hay, farm No. 5

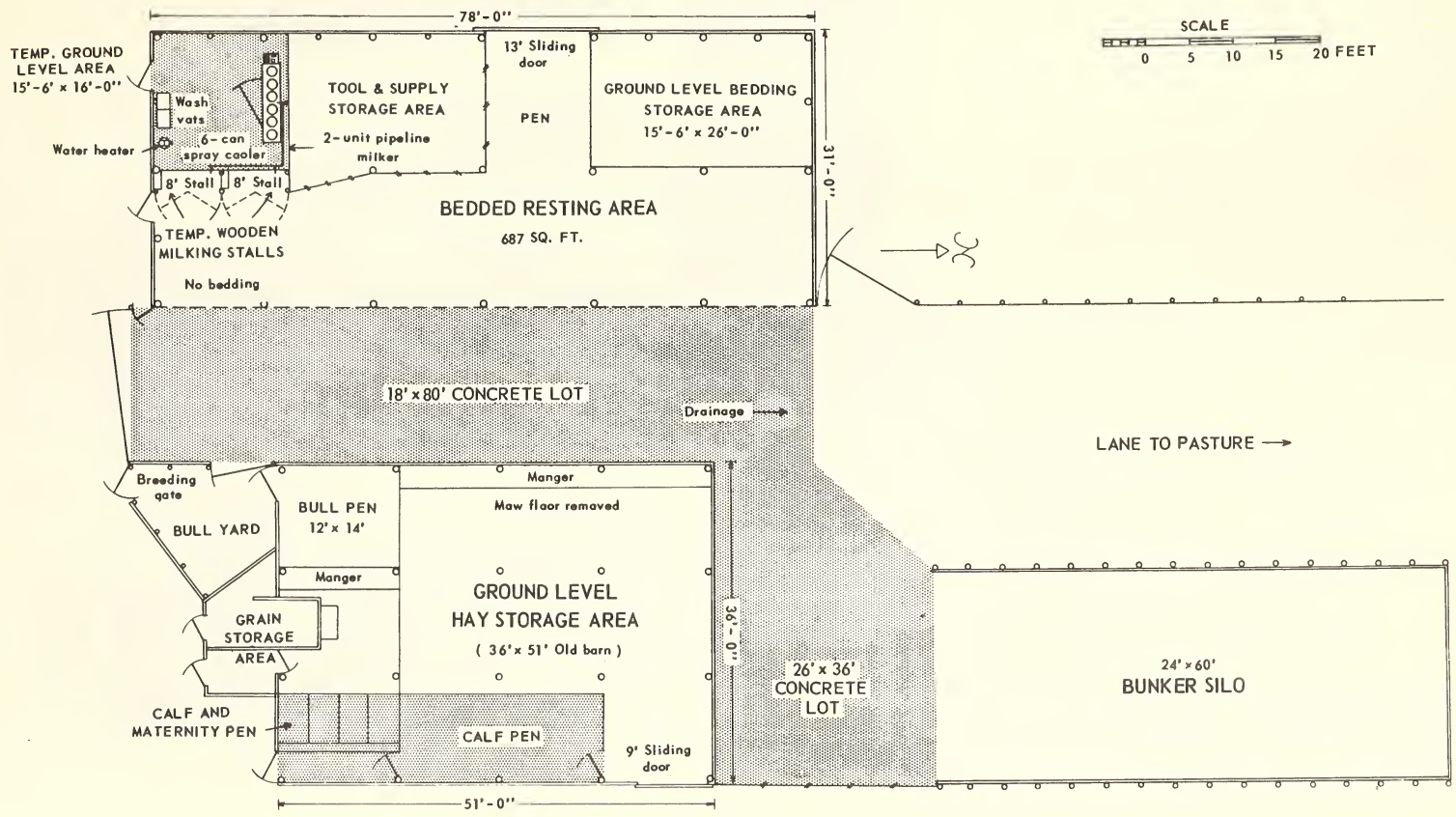

Figure 9.- Arrangement of open temporary milking facilities, phase 2 (1950) farm No. 5.

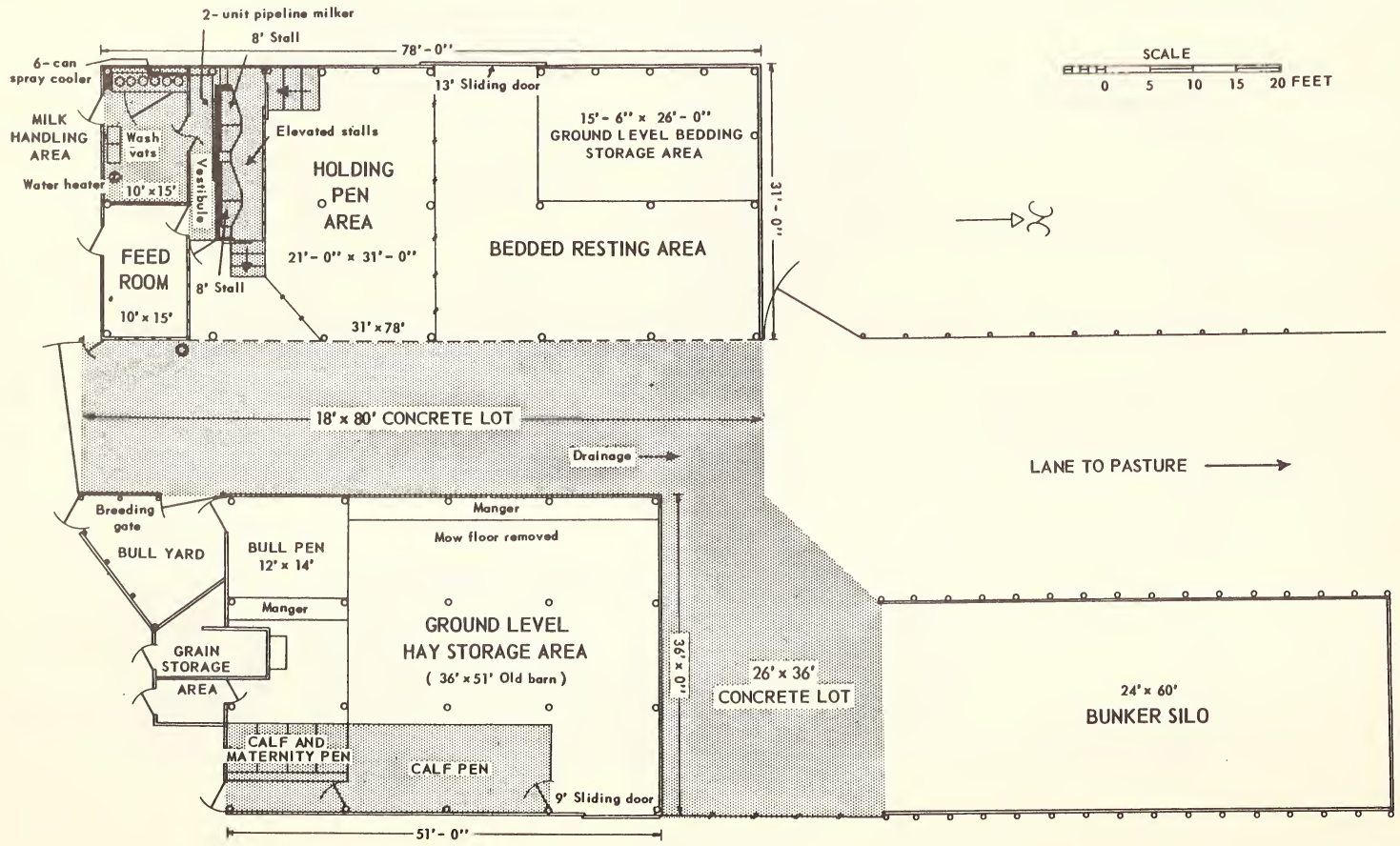

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Figure 10.- Present layout and arrangement of buildings and facilities, farm No. 5

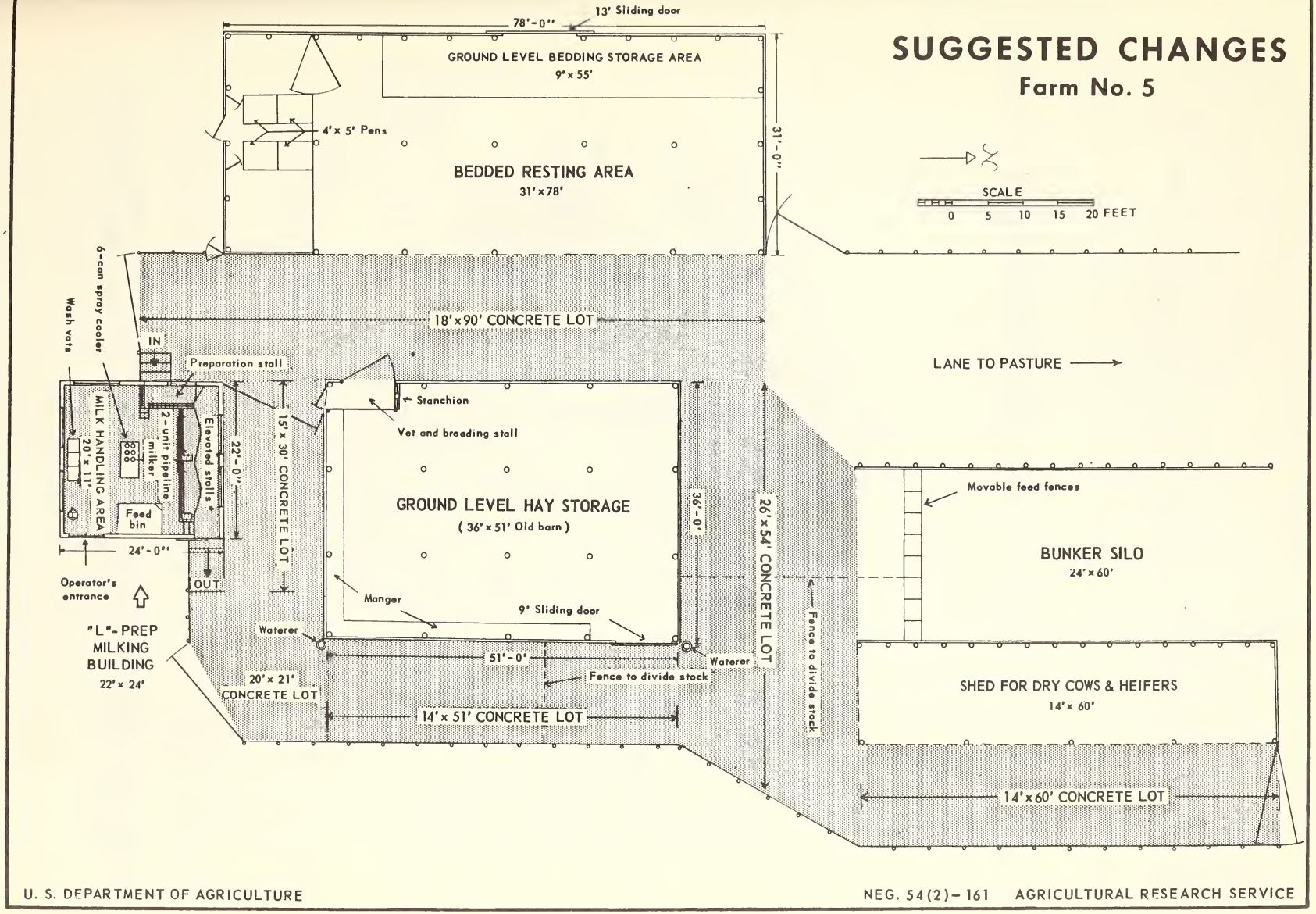

Figure 11.- Suggested changes in layout and arrangement of buildings and facilities, farm No. 5.

The original barn on farm 5 was arbitrarily appraised at $557, or about $80 per cow, based on full utilization of the space by 7 cows (table 1). New facilities added in phase 2 consisted of a loose-housing shelter, concrete lot, hardware, wiring, temporary milking stalls and dairy equipment, including a spray cooler and pipeline milker (figs. 12 and 13). This brought the investment to $3,838, and increased the capacity to 25 cows for a total investment of $154 per cow.

MILKING ROOM WITH A PREPARATION STALL
PREP. STALL
WALL FEED BIN
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NEG. 54(1)-108 AGRICULTURAL RESEARCH SERVICE

Figure 12.- Milking room with a preparation stall and two elevated milking stalls for a one-man operation with two pipe-line milker units.

Table 1.- Summary of building and equipment costs by structural phases for farm 5, (1950 local prices)

Phase	Purpose	Total actual cost	Est. normal cost 1/	Accumulated cost
		Dollars	Dollars	Dollars
1	Old barn, (1950 appraised value).....	557	557	557
2	Shelter - 31' x 78' barn			
	Labor..... $ 352			
	Materials..... 1,227			
	1,579.....	1,579	1,579	2,136
2	Concrete lot - 16' x 80'.....	284	337	2,473
2	Miscellaneous hardware and electric wiring.	143	143	2,616
2	Open milking area equipment 2/.....	1,326	1,222	3,838
4	Elevated milking and milk-handling room, feed room, and other additional equipment.			
	Labor.....$ 342			
	Materials..... 543			
	Equipment..... 729			
	1,614.....	1,614	1,348	5,186
5	Partition in milking area.....	122	124	5,310
5	Miscellaneous equipment and facilities.....	75	58	5,368
5	Bunker silo - 24' x 60'			
	Materials..... $ 661			
	Labor..... 142			
	803.....	803	803	6,171
		6,503		

Number of cows and cost per cow by phases

Phase	Number of cows	Cost
	Number	Dollars
I	7	80
II	25	154
IV	25	207
V	25	247
V	3/ 40	154

1/ Prices at which adequate materials, equipment, and labor were normally available. Operator sometimes paid less or more for certain items.

2/ Salvage material used for temporary milking stalls.

3/ Estimated capacity of existing facilities based on use of bunker silo and space not needed for hay storage.

Figure 13.- New resting barn on farm No. 5 with the open side facing east. The lot in the foreground is paved. Note straw storage along the back wall of the barn and the absence of any well-defined traffic lanes.

In phase 4, an additional $1,348 was invested in elevated stalls, milk-handling room, feed room, and other equipment, thus increasing the investment per cow to $207. Finally, in phase 5, adding the milkroom partition, bunker silo, and miscellaneous items increased the total investment to $6,171, or $247 per cow for a 25-cow herd. But the change from hay to silage released enough storage space to shelter 15 more cows, so that if 40 cows were kept the investment would be reduced to $154 per cow (fig. 14).

On six farms from which detailed records were obtained, the total investment in buildings and equipment ranged from $194 to $383 per cow capacity. On three farms on which maximum capacity was obtained through separate hay storage, bunker silo, arrangement of buildings, and other items, the total investment in physical facilities was reduced to around $200 per cow.

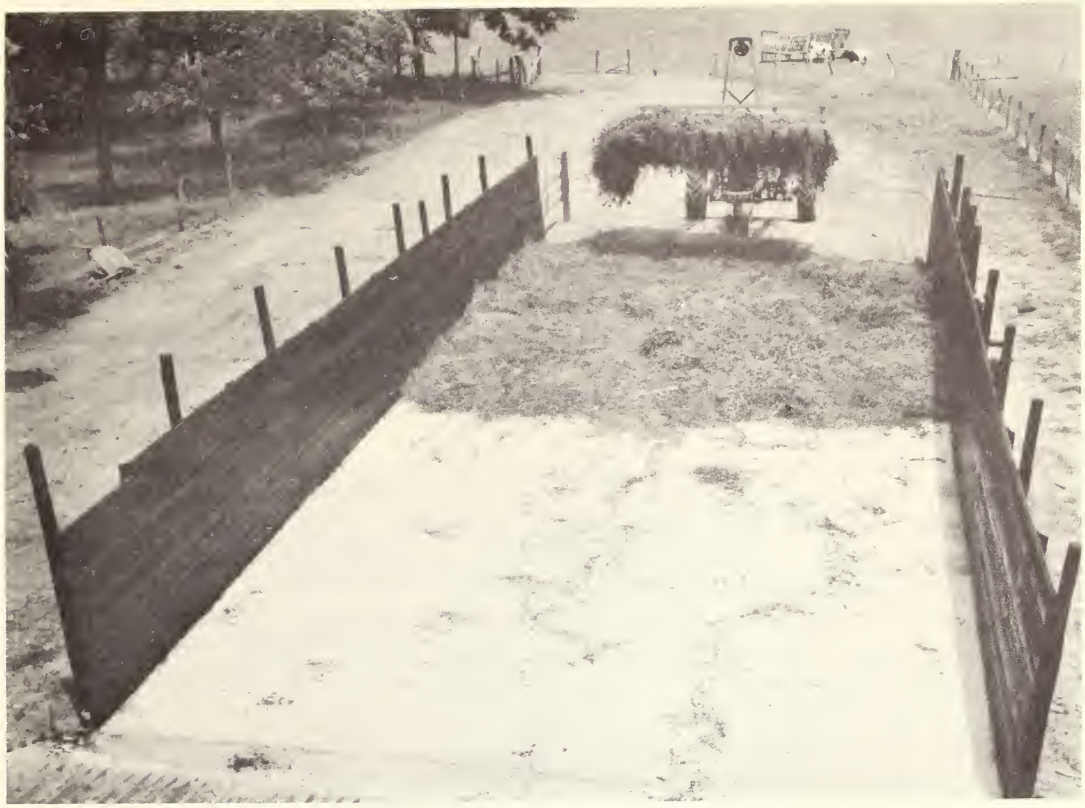


Figure 14.- First cutting of red clover was put in this 24' X 60' X 6' bunker silo on farm No. 5. Twenty-seven dairy cattle were self-fed by means of movable feeding fences during nearly 2 months of drought in the summer of 1953. The silo was refilled with corn silage for winter feeding. Extra length posts were provided for possible extension of sidewalls or addition of lean-to shelters on either side.

Investments such as these reduce the annual cost to a relatively low figure. On farm 5 about $4,400 of the $6,171 total investment was for buildings. With an estimated 25-year useful life, or 4-percent annual depreciation and an additional 5½ percent to cover interest, repairs, taxes and insurance, the annual cost would be $418 for the dairy buildings. The initial cost of equipment was nearly $1,800. Allowing 10 percent of this for annual overhead, the annual cost for buildings and equipment would be $598, or about $24 per cow for a 25-cow herd. If 40 cows were kept, annual costs would be $15 per cow.

In open-shelter barns, large quantities of bedding may not be required. On farm 5, the capacity was increased and the quantity of bedding needed was reduced by storing the bedding along the back wall of the barn, eliminating traffic lanes in the resting area, and using the old barn for feeding hay. Cows were kept clean with from 35 to

50 square feet of space available per head and about 475 pounds of bedding per cow per year on the average for the 3 years. Of this quantity, 422 pounds were straw. A small quantity of sawdust was also used in the third year. Labor for bedding the cows averaged about 1.14 hours per cow per year for the 3 years, but it was reduced to only 0.91 hour per head in 1952-53 (table 2).

USE OF LABOR

Chore labor was greatly reduced by planning, better arrangement of buildings, use of equipment, and methods adopted specifically to increase efficiency. Such gains in efficiency of labor also made possible increases in size of herd which further reduced the average amount of time spent in caring for each cow.

Based on time and travel studies, it was estimated that as many as 225 hours per cow per year were spent on some of these farms at the beginning of the study; the average estimate for the area was 120 hours. On 6 farms in the experimental group the average was about 155 hours in the first year of study. In the completed arrangements chore labor on these farms averaged only 58 hours per cow per year. These data include all dairy chores except caring for young stock. They do not include harvesting and storing feed and bedding.

Again, farm 5 serves as a case in point. In the initial period with 4 cows, the total chore time for milking was 60.6 minutes, or 15.5 minutes per cow. 6/ The actual milking took more than 50 minutes, Total annual chore time per cow during this period, including milking, feeding, hauling manure, and bedding the animals was about 190 hours.

Table 2.- Annual quantities of bedding and labor for bedding used on farm 5

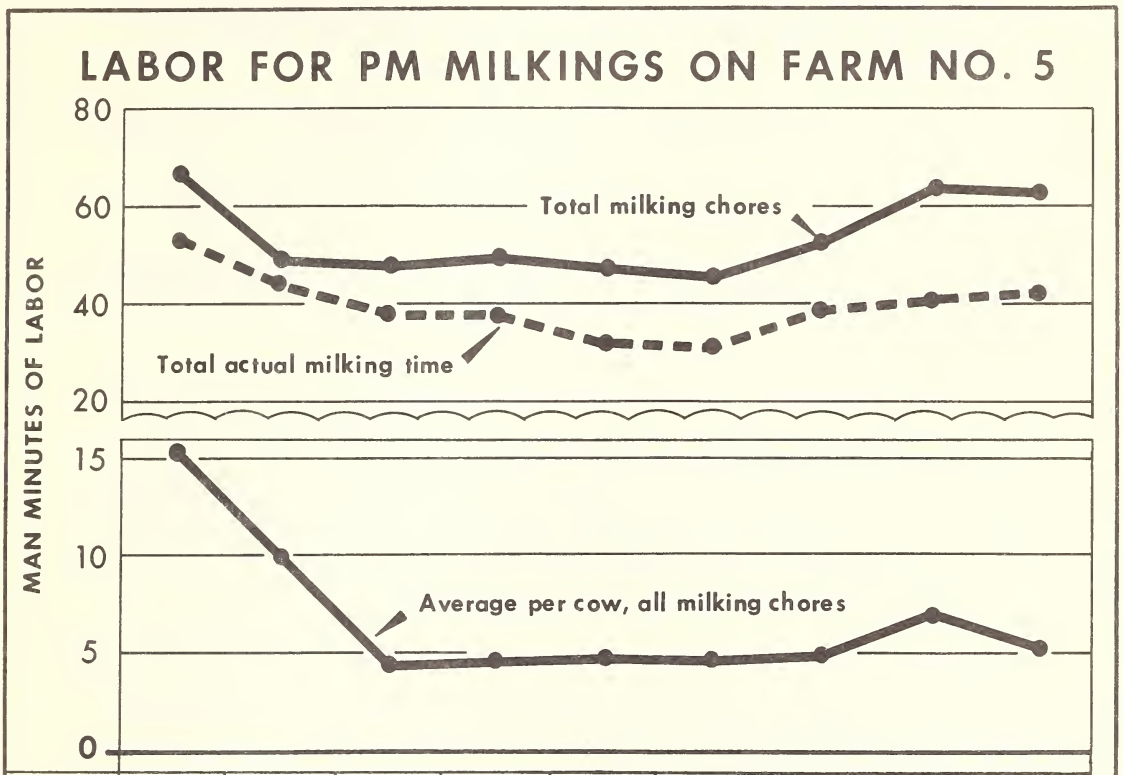
Housing season	Average number of head 1/	Average square feet per head per season	Total pounds of bedding 2/	Total pounds per head	Total hours annual labor for bedding chores	Average hours per head per year
	Number	Sq. feet	Pounds	Pounds	Hours	Hours
1950-51	17.2	41	7,975	464	27.64	1.61
1951-52	21.8	39	9,185	421	21.64	.99
1952-53	21.8	43	8,380) 3,500)	straw(384 sawdust(161	19.78	.91

1/ Includes milk cows and heifers sheltered in bedded area according to actual number of days each animal was housed.

2/ Wheat straw except during 1953 when 3,500 pounds of sawdust were distributed in three applications through January, February, and May.

6/ Milking chore time includes time spent getting ready to milk, milking, and clean-up of equipment and facilities after milking.

The second year the herd was increased so that 11 cows were milked. Various facilities were added. Chore time per cow per year was reduced to 49 hours. Adding a partition between the milking and milk-handling areas during the third year and intensifying cleaning practices, increased annual chore time to 60 hours per cow. During both the second and third years milking chore time per cow generally ranged from 4 to 6 minutes. (See figure 15 for details and minor variations.)



DATE	5-15-50	9-16-50	4-7-51	5-10-51	6-19-51	3-11-52	4-25-52	3-30-53	6-19-53
NO. COWS	4	5	11	11	10	10	11	9	12

5-15-50, HAND MILKING IN ORIGINAL FACILITIES; 9-16-50, HAND MILKING IN OPEN MILKING AREA, USING TWO TEMPORARY WOODEN STALLS AT GROUND LEVEL; 4-7-51, SEVENTH MILKING IN ENCLOSED ELEVATED MILKING AREA WITH STAINLESS STEEL PIPELINE, CONCRETE FLOORS, NO PARTITION BETWEEN MILKING AND MILK HANDLING AREA; 5-10-51, FIFTH WEEK IN SAME FACILITIES – NO CHANGES; 6-19-51, TENTH WEEK IN SAME FACILITIES – NO CHANGES; 3-11-52, SEVENTH MILKING IN SAME FACILITIES, BUT A PARTITION WAS ADDED BETWEEN MILKING AND MILK HANDLING AREAS; 4-25-52, 3-30-53, 6-19-53, SAME FACILITIES BUT ROUTINE PROCEDURES AND METHODS WERE ADAPTED TO WORK PATTERNS REQUIRED BY THE CHANGES IN FACILITIES AND SANITATION PRACTICES.

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Figure 15.- Labor for all PM milking chores, actual milking time, and average time per cow for all milking chores on farm No. 5.

Chore time on farm 5 was reduced by such means as a planned arrangement, milking machines, elevated stalls, mechanical equipment, and use of facilities at or near maximum capacity. Observations on all experimental farms indicated that the features that contributed to efficiency of labor were:

Ground-level storage of hay and silage, with provision for self-feeding and direct movement of materials from storage to racks and bunks.

Elevated stalls and an arrangement for bringing the cows to the operator.

Arrangement of resting area and location of bedding storage to minimize quantity of bedding and amount of labor for bedding.

Utilization of equipment such as pipeline milker, spray cooler, water heater, and other standard equipment.

Work routines to reduce idle time of the milker units.

Use of a preparation stall in addition to two milking stalls to get the cows ready for milking.

SUGGESTIONS

For Dairy Buildings and General Management Practices

Recommendations derived primarily from previous research and experience are given here as general guides to improvement in dairy housing and management. The study reported here provided additional evidence regarding some of these recommendations.

Dairy buildings and their arrangement should permit labor-saving methods of operation and should make it easy to follow good production and sanitation practices. They need not be elaborate or expensive. Some general principles to follow in a building program to obtain effective arrangement and utilization, as well as low cost per unit capacity are:

Build one-story barns - they are less expensive and can be easily adjusted to meet changing needs. Hay and straw can be stored at ground level.

Leave the south or east side of the building open for ventilation, lighting, and convenient access for both cattle and equipment.

Store bedding along the back wall of the resting area. This will eliminate pressure of manure against the wall and prevent damage by animals and power equipment. Also, less costly materials are needed for the wall.

Locate calf pens for convenient access from the milk-handling area without going through the feedlot.

Keep the milking and milk-handling area separate or independent from the shelter structure to simplify problems of light and ventilation, and to increase the capacity of the resting area.

Use an outside holding area, sheltered from the wind, to minimize requirements for bedding and space, or use a holding area inside the shelter barn but separate from the resting area.

Provide a hay-feeding area open to the south or east and located away from the resting area. This will reduce bedding requirements.

Provide a separate feeding and shelter area for dry cows and young stock to simplify handling the herd and to reduce requirements for bedding and labor.

Consider horizontal storage of silage in stacks, trench, or surface silos located conveniently near the lot for feeding directly from storage.

Locate upright silos outside the feedlot to be used with fence or lot-feeding bunks.

Place watering cups or tanks along the edge of the feedlot or hay manger away from the bedded area. Use automatic controls to save labor and heat to prevent freezing.

Pave lots and feeding areas. It is not necessary to pave the resting area.

Build the milking and milk-handling areas as a single enclosed unit, if permitted by regulations, to obtain greater chore efficiency and better observation of the milking operation. A partition between the two areas reduces efficiency in cleaning and in doing other chores.

Build elevated stalls to eliminate bending and stooping. This arrangement will permit a fast milking program and better care of each cow during the milking operation. Sometimes an additional stall for preparing the cows for milking may increase efficiency of operations.

For Sanitation Practices

Successful production of high-quality milk depends primarily on adequate sanitation practices. The necessity for these practices has been established by previous research and experience. Previous research and results of this project indicate rules that are good to follow when loose-housing and pipeline milkers are used:

Have the cows clean at milking time. A well-bedded resting area will help to keep them clean.